the blood cells the appearance of multiple drops into which the granuloplasm moves subsequently as it does into typical pseudopods. Transition can be observed between these drops and the typical pseudopods.

It is also possible to produce experimentally in the amœbocytes structures which very closely resemble ova in which maturation membranes have formed. Jacques Loeb has formerly shown that this formation depends upon a proces of cytolysis. In the blood cells these structures appear under conditions in which the cell has taken up fluid from the surrounding medium and the consistency of the protoplasm resembles that of a liquid. All kinds of transition between these structures, drop pseudopods and the typical tongue-like pseudopods can be found. These and other observations very strongly suggest that the formation of pseudopodia, the appearance of drops at the surface of the cells and the formation of fertilization membranes are related phenomena and that the latter two conditions represent extremes in a process which, when acting in medium intensity, leads to the formation of the typical pseudopodia.

4. Through changes in the consistency of the protoplasm in the blood cells of *Limulus* it is possible to imitate the structures corresponding to different tissues. Especially did we obtain in certain cases through an increase in the consistency of the cells tissues which resembled those composed of ganglia and glia cells. It may thus be possible to obtain indications as to some of the conditions which induce the cells of different tissues to assume different forms.

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The Relative Numbers of Twins and Triplets[1]

It may be of interest to call attention to a simple relation between the number of human twin and triplet births. The relation was noticed a number of years ago and I supposed it had been recorded, but a search has failed to reveal any published statement.

If $1/n$ is the proportion of twin births to all births in a large population during any period, then the proportion of triplet births during the same period is very near to $1/n^2$. The agreement of the data is often startling. Thus in 13,360,557 births in Prussia during the years 1826–1849 as recorded by Veit[2] the number of twin births is one in 89.1 and the number of triplet births one in $(88.9)^2$. In 1,339,975 births in the United States registration area in 1917[3] the number of twin births is one in 93.1 and the number of triplet births one in $(93.0)^2$.

From the statistical relations it would appear that triplets are produced by the coincidence of two independent processes occurring with equal frequencies. One of these processes by itself gives rise to twins. This relation would apply to any mode of origin of multiple births or to different combinations of them provided that each followed the rule.

The principle might be applied to the two chief explanations of multiple births as follows:

1. *Multiple Ovulation.*—Normally a single ovum is discharged from the ovaries. There is some coordinating mechanism which prevents the ripening of other ova at the same time. Suppose that as a result of a purely intrinsic factor, once in n times an ovum appears which fails to respond to this mechanism. The chance that two such extra ova will appear at the same time is once in n squared. Obviously this presupposes that the failure to respond is due to independent processes in the two ova. To put the case more concretely, suppose that the approach to maturation of an ovum is accompanied by an internal secretion which acts upon other ova and keeps them from completing the process at the same time. The overwhelming major-

[1] Contribution from the Zoological Laboratory of the University of Illinois, No. 172.

[2] Veit, G., 1855, *Monatsschrift für Geburtskunde und Frauenkrankheiten*, 6: 127.

[3] Birth statistics for the birth registration area of the United States, 1917, U. S. Bureau of the Census, Washington, 1919.

ity of the ova would be properly inhibited but occasionally an ovum would fail to respond because of some peculiarity in its organization. Suppose that such peculiarities are due to local factors appearing with a frequency of $1/n$. Then the chance that two such independent local factors will act at the same time and thereby cause the simultaneous discharge of two supernumerary ova is $1/n^2$.

2. *Monozygotic Twins and Triplets.*—Normally a single embryonic area appears in the blastodermic vesicle and through some coordinating mechanism inhibits the formation of additional embryonic areas. Suppose that once in n cases a cell or group of cells acquires physiological independence as the result of an intrinsic factor and forms a second embryonic area. The chance that two such cells or groups of cells will arise at the same time is once in n squared if it is supposed as in the previous case that the two events are independent of each other.

In order that the stated numerical relations may ensue, the important consideration in either mode of origin of multiple births is the independence of the two events which give rise to triplets. If, in the fluctuations of the general physiological state of the mother, the condition is sometimes such as to result in twins and sometimes in triplets, it is hard to see why the "square" relation should exist. For instance if it is postulated that additional ova are stimulated to complete the maturation process as a result of an unusual amount of an internal secretion and that the number of extra ova depends on the quantity of the secretion there is no reason for expecting the observed relation between one extra and two extra embryos. This difficulty seems to apply to all general agents that may be postulated as acting upon the ovaries as a whole in the cases of multiple ovulation or upon the developing embryo as a whole in the case of monozygotic twins and triplets. If, however, each supernumerary ovum is due to an independent local action and such local actions have a certain average frequency the coincidence of two such actions would give the observed numerical relation of triplets to twins.

If the explanation as stated applies to the relation between triplet and twin births it is to be expected that it will apply to quadruplets as well. In that case the expected number of quadruplets is one in n^3. Unfortunately the numbers are too small for a reliable conclusion. In the largest available collection of data, the one mentioned above, there are 36 quadruplets in 13,360,557 births or one in $(71.9)^3$ which is somewhat greater than the expected number, one in $(89.1)^3$.

As in other statistical relations the biological significance in the present instance can not be proved directly from the mass of data. When one considers the vicissitudes of fertilization, the chances of death of individual embryos, the demonstrated influence of the spermatozoon in certain cases of twinning and numerous other biological factors, to say nothing of faulty registration statistics, it is hard to believe that the simple numerical relation of triplets to twins can be more than the result of the combination of numerous and as yet unanalyzed forces. A knowledge of the fact may, however, aid in the analysis.

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The sugar industry of Peru: CHAS. A. GAMBLE.

Electric oven for rapid moisture tests: G. L. SPENCER. This oven (patented August 3, 1920) is a convenient arrangement for passing a rapid current of heated air through a sample. The air is drawn over a heating element, composed of a spiraled nichrome wire coiled around a suitable core, and thence through the sample contained in a capsule, fitted with a gauze or metal filter-cloth bottom. The temperature of the air is controlled by a rheostat. Any substance through which a current of hot air may be passed, without melting, may be dried in this oven. Raw sugar may be approximately dried in 3 minutes and to constant weight in 10 minutes; 100 gram samples of cane bagasse are dried in less than 60 minutes; cotton saturated with water is dried in 10 minutes.